Circular No. 6087
November, 1928.

INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE--BUREAU OF MINES

ROCK-DUSTING BY HAND METHOD[1]

By D. Harrington[2] and C. W. Owings[3]

The belief is now fairly general among the coal-mining people of the United States that one of the most effective methods of preventing wide-spread coal-mine explosions is that of introducing rock-dust into coal mines to reduce the inflammability or explosibility of dusts found on mine surfaces. Notwithstanding this belief it is improbable that even a small fraction of 1 per cent of the coal mines of the United States are at all adequately protected by rock-dust; in a survey made in the summer and fall of 1927 it was found that but 463 out of more than 7,000 operating bituminous and lignitic coal mines were using rock-dust at all, and that few if any of the 463 were fully or adequately protected by rock-dusting.

Inspections of a large number of mines through the United States by Bureau of Mines safety division field men have failed to reveal a single adequately rock-dusted mine, yet there is no doubt that many of the owners and operators believed their properties to be fully protected by rock-dust against the much-feared hazard of widespread explosion. Two of the most disastrous explosions of recent years occurred at properties where the owners were definitely of the belief that the rock-dusting done had made the mines immune to widespread explosion involving coal-dust. In both instances it was found that although some rock-dusting had been done, the mines were more nearly 1 per cent than 100 per cent rock-dusted.

This condition as to inefficiency or insufficiency of rock-dusting in the coal mines of the United States is almost universal, and unless our mining men awaken to its dangers, the disaster record of the coal-mining industry is much more likely to become worse than better. During the fiscal year ended June 30, 1928, the attention of the safety division of the United States Bureau of Mines was called to 22 explosions with 320 fatalities in bituminous coal mines of the United States; and of the 22 explosions there were 10 with 258 fatalities in mines that were listed as having used rock-dust; upon investigation it was found that as usual the rock-dusting had been anything but comprehensive or adequate.

---

1 The Bureau of Mines will welcome reprinting of this article but requests that the following footnote acknowledgment be used: "Printed by permission of the Director, U. S. Bureau of Mines. (Not subject to copyright.)"

2 Chief engineer, safety division, U. S. Bureau of Mines.

3 Associate engineer, safety division, U. S. Bureau of Mines.

Digitized by Google

It is probable that in a very few instances last year the relatively small amount of rock-dusting stopped the extension of the explosion and thus prevented further expansion of the death list. In general, however, the explosions occurred in a part of the mine that had not been rock-dusted - and right here is the crux of the failure or probable failure of present-day rock-dusting in the United States. There should be no part of any bituminous or lignitic coal mine in which all of the exposed surfaces (roof, ribs, and floor) have not been thoroughly rock-dusted and kept thoroughly rock-dusted. In other words, all exposed surfaces of all accessible places in bituminous and lignitic coal mines should be kept covered with rock-dust so that the combined rock-dust-coal-dust mixture at all times and in all places has less than 35 or 40 per cent combustible matter. The only exception to this rule is that surfaces which are wet (and this does not mean merely damp) need not be rock-dusted. However, a mine opening may have several inches of water on the floor and yet have much explosive dust on the ribs and roof above the water; in such places the ribs and roof should be kept rock-dusted, irrespective of the wetness of the floor.

There are many reasons why rock-dusting has not been more widely adopted and why it has not been done more efficiently where it has been adopted in principle. The greatest trouble is that mining men seem in general unable to grasp the underlying principles of rock-dusting; many of the attempts at rock-dusting of mines would be amusing or ridiculous if they were not tragic or at least likely to become tragic. Rock-dusting is intended chiefly to prevent coal-dust from extending explosions which have been started; and since explosions may start at practically any point in a mine, it is, or at least should be, obvious that every point in the mine which has explosive dust should have protection against the feeding of the explosion by the dust. Since as little as 1 pound of bituminous or lignitic coal-dust per linear foot of ordinary entry will feed or extend an explosion, it is easy to see that practically all mine openings have a sufficient quantity of dust present to be dangerous. There is absolutely no question that all bituminous and lignitic coal mines, whether gassy or so-called nongassy, require thorough rock-dusting of all accessible surfaces that are not decidedly wet, unless the settled dust has less than 35 or 40 per cent combustible matter.

Up to the present, rock-dusting has not been recognized as a necessary daily operating practice, and until it becomes as fully a matter of routine daily procedure as timbering, blasting, ventilating, loading, and hauling, rock-dusting is certain to fail as a sure preventive of widespread disasters. At present the best of our rock-dusted mines keep possibly 25 per cent of the mine surfaces adequately covered with rock-dust and some of our so-called rock-dusted mines have only a fraction of 1 per cent of the surfaces covered. Frequently a main haulage road is well rock-dusted while its 1, 2, 3, and up to 6 or 7 parallel air courses (the surfaces of which are dry and covered with explosive dust) are absolutely devoid of protection, the situation resembling much the completeness of the hiding of the ostrich when he sticks his head in the sand.

Digitized by Google

In some instances three or more main entries, including the main haulage road and its parallel air courses, are fairly well rock-dusted, but no attention is paid to the side entries from which the rooms are turned and in the vicinity of which are the most of the operations likely to bring about an explosion. And there are so few mines which rock-dust the rooms or the open abandoned places in mines that their total number in the United States can undoubtedly be designated by the fingers of one man's hands.

One of the many factors which have prevented widespread and adequate rock-dusting is the almost unanimously accepted inference in the United States that rock-dusting can be done only by machinery; up to the present no machine has been available that would keep all types of accessible mine surfaces adequately covered with rock-dust or that would do it without a considerable expenditure of labor and money. It is true that there are excellent machines for the comparatively inexpensive and effective rock-dusting of mine openings where trolley lines are available for the operation and transportation of the machine, but generally these machines are comparatively ineffective or at least very costly for the rock-dusting of regions where there is no track or no trolley wire; there are mechanical means of rock-dusting trackless places by high-pressure blowers or compressed air, but these methods are somewhat expensive and cumbersome.

In so far as room treatment is concerned, probably the worst handicap to the widespread rock-dusting of mines is the fact that air currents are almost invariably sluggish in rooms and the use of any kind of mechanical rock-duster throws such large quantities of dust into the air that room air currents fail to take the dust away quickly or effectively enough to allow the workers operating the rock-dusting machine to remain in any one place a sufficient time to do the dusting thoroughly. The machine operators are at so much disadvantage in seeing and breathing while room-dusting that rarely is the rock-dusting well done. Moreover, it is far more difficult in room than in entries to reach the longer distances to the ribs or through the timbers or gob; and in low coal although the entry roof is usually brushed to give head room, the room roof is seldom brushed, so that rock-dusting of such rooms by machine becomes almost impossible. For these as well as other reasons rooms are seldom rock-dusted.

Up to the present, rock-dusting of coal mines in the United States has been considered as almost wholly devolving upon the operating company, and in general the underground workers are relieved of any part or responsibility or even interest in the matter; in fact, it is curious to note the apathy of the miners toward rock-dusting. Rarely does one find a rock-dust advocate among the rank and file of the mine workers, and even more rarely is any concerted demand made by them for the introduction and maintenance of adequate rock-dusting of mines. There is absolutely no question that rock-dusting is of fully as much benefit to each and every one of the underground workers as it is to the operating company, and there is no good reason why the mine worker should not shoulder some of the burden and responsibility of making the mine safe for himself and his coworkers. It is very probable that not until the miner shoulders

Digitized by Google

his share of the responsibility for the maintenance of rock-dusting in mines will our coal mines be kept adequately rock-dusted.

In many of our coal mines, especially in the western part of the United States, water under pressure is piped by the company to or near the working face and the face worker is supplied with water hose and is required by custom, by company rule, or by law (or by all three) to keep the face region watered or sprinkled; in at least some mines the miners do the watering thoroughly, because it is they who benefit chiefly by the lessened amount of dangerous and unhealthful dust which gets into the air when the coal pile, top of loaded coal cars, and face surfaces are not kept well watered. Here the company and the workers share the responsibility, the company in placing the water under pressure and providing the water hose, the workers in using the hose and water to help make their places and the entire mine more safe and more healthful. There is absolutely no valid reason why essentially the same system can not be used with rock-dusting and there is every reasonable argument why it should be in effect. Every mining company operating a bituminous or lignitic mine in the United States and having any underground workings which are not absolutely wet, should be required to keep on hand at a reasonable distance from every working face or place that is not absolutely wet a plentiful supply of rock-dust suitable for rock-dusting to prevent explosions, and the rock-dust should be supplied as freely and as systematically and consistently as timber, or rails, or ties, or empty cars. The face worker should be required to throw this dust by hand or by shovel or some similar method against the ribs, roof, timbers, and floor so as to have on entry room and cross-cut surfaces 5 to 10 pounds of rock-dust per linear foot of advancing opening. These requirements should be part of the State law and every State coal mine inspector of bituminous or lignitic mines should be expected to enforce these requirements in all mines large or small, with at least as much vigor and diligence as he enforces laws or regulations as to timbering and ventilation.

Under the ordinary methods of mining, very few entries or rooms advance more than 5 feet per day; hence to cover the surfaces with the required 5 to 10 pounds of rock-dust per linear foot of advance would require 25 to 50 pounds of rock-dust per shift, the placing of which should not require more than 10 or 15 minutes of the miner's time. Surely this is no "burden" which the face worker should dread, and just as surely it is one which he can not afford to shirk or avoid.

A mine operating in a 5-foot seam with entries and crosscuts 12 feet wide, rooms 22 to 24 feet wide, and an output of about 1,000 tons per day from advancing rooms and entries will ordinarily produce approximately 25 per cent of the coal from narrow (entry or crosscut) work and 75 per cent from room work, hence there will be a daily advance of about 100 feet in narrow work and of 150 to 175 feet in room work. If the face workers place 5 pounds of rock-dust per foot of narrow work and 10 pounds per foot of room advance, the total rock-dust consumed per day by the face workers in hand-dusting would be about 500 pounds in the narrow work and 1,750 pounds in the room work, a total of 2,250 pounds or 1 1/8

Digitized by Google

tons of rock-dust per shift. Thus in a mine producing 1,000 tons a day about 1 ton of rock-dust per day will keep all of the advancing faces in a 5 or 6 foot seam thoroughly rock-dusted, and the mine will undoubtedly be much more adequately dusted than has been true of any mine in the United States to date. Rock-dust f.o.b. the mine usually costs less than $10 per ton and at least in some localities can be had for as little as $5 per ton; hence the system of rock-dusting by which the company supplies the dust and the face worker applies it to the mine surfaces as the workings advance, will give thorough rock-dusting to so-called trackless as well as to track or haulage mine openings at an expense to the mine of much less than 1 cent per ton of coal produced, and the 10, 20, or 30 minutes per day, or possibly every alternate day, used by the miner in the distribution of the rock-dust is most certainly not an unreasonable contribution on his part to the safety of the mine and its workers, including himself.

Rock-dusting by hand does not generally place in the air any considerable amount of dust, hence the hand-dusting of rooms or other regions with sluggish ventilation is done with practically no difficulty. The rock-dust should not be mixed with the coal as it is shot down, therefore the hand rock-dusting of the advancing regions should be done after the coal has been loaded out; preferably it should be done as one of the last acts of the face worker before he leaves his place to go home. The rock-dust should not be thrown against the face to be shot down or on the immediate floor on which the coal will fall after blasting. The ideal condition is obtained when the actual face and surfaces for a distance 25 to 40 feet back from the face are kept wet by water from a hose and the rock-dusting by hand is maintained on advancing surfaces up to about 25 to 40 feet of the actual face.

When the hand rock-dusting of the face by the worker using rock-dust supplied by the company is arranged for, the matter of maintaining in a safe condition the rock-dusting of the haulage entries and other places as the faces advance will remain. This will be the duty of the company. With the good basic coating done by the face worker the burden of maintenance should be light, and in fact should be confined almost wholly to haulage entries and to the non-haulage workings where travel is done. Where rock-dusting machines can be used there should be little trouble in redusting 1,000 to 2,000 or more feet of haulage road in an 8-hour shift, and with the before-mentioned heavy basic coating placed on the air course or other trackless entry surfaces by the hand dusting when on advance, redusting can generally be done effectively and advantageously in these trackless places by using the air currents.

A sufficient number of samples of dust should be gathered each month on each split of air and tested either by chemical analysis or other method acceptable to the inspector to determine if any part of the mine requires redusting. A sample should be taken in the following manner: A groove 6 inches wide across a floor from rib to rib should be made in the loose, fine material, by scoop or other means, to a depth of 1 inch, if feasible. Also a 6-inch strip of dust should be brushed from both ribs, roof to floor, and from rib to rib along the roof if dust is adhering to the roof; where the entry has timber sets,

Digitized by Google

a dust sample should be brushed from the top of one collar to 6-inch width, if feasible, and from the lagging, if any. All the material thus sampled should be screened through a 20-mesh sieve before being tested. The sample from the floor should be taken and analyzed separately from the rib, roof, and timber sample; this is important. Such mines or parts of mines where the fine material (dust) is considered to be sufficiently wet not to require rock-dusting should be sampled at least once a month; the samples should be analyzed to show the moisture content and a copy of the analytical results sent to the mine inspector. Whenever such samples show a moisture content of less than 25 per cent, the fine material (dust) in the mines or parts of mines should be considered of an explosive nature, and rock-dusting should be done. A record should be kept in a book provided for that purpose, showing the location at which samples have been taken and the results of the analyses or tests.

Moreover, when necessary to redust trackless places the dusting can be done by hand methods much less expensively than is usually believed, unless access to these areas is particularly difficult. In a Pennsylvania mine over 1 mile of entry was hand-dusted at a cost of a little over 7 cents per linear foot of entry and with placement of about 7 pounds of dust per foot; the cost of machine-dusting in this mine, including labor and material, was 4 cents per linear foot of entry with placement of 6 pounds of rock-dust per linear foot of entry. In another Pennsylvania mine, hand-dusting costs 4 cents per linear foot of entry, using but 3 pounds of dust per foot, and machine-dusting costs but 2½ cents per foot, using the same amount of dust. In another mine in Pennsylvania a relatively small amount of hand-dusting of entries cost 4½ cents per linear foot, using 4½ pounds of dust per foot of entry; and a comparatively inefficient machine covered a much larger footage of entry with 5¼ pounds per linear foot at a cost of 5¼ cents per foot. In an Illinois mine two-men crews hand-dusted much entry footage, carrying dust in pails and throwing it by hand, the cost being 5 cents per foot and the quantity placed about 8 pounds per foot of entry. The track entries in one Pennsylvania mine were dusted with 3¼ pounds of dust per linear foot at a cost of 2½ cents per foot, and trackless entries were hand-dusted with 9¼ pounds of dust per linear foot, the cost being 6¼ cents per foot; here the cost of hand-dusting the trackless entries was more than double that of machine-dusting the track entries, but the larger quantity of dust placed in hand-dusting the trackless entries was much the more efficient and in the long run the least costly.

In connection with the rather expensive hand-dusting of trackless entries in the last mine cited, an estimate was made of the relative costs of hand-dusting the trackless entries and of erecting up-to-date rock-dust barriers, the protection of the region by actual hand-dusting being slightly over $800 against an estimated cost of about $3,200 for the barriers; the hand-dusting is much the more reliable, and probably the more durable, in addition to costing only about one-fourth as much as the barriers. Although rock-dust barriers when properly constructed and maintained have definite value in the retardation or limiting of explosions, yet at least 90 per cent of the rock-dust barriers as installed in mines are practically valueless; hence time and money invested in efficient hand rock-dusting will be far more likely to repay with the necessary protection of

Digitized by Google

the mine and its workers than the fruitless expenditures of time, money, and effort now going into rock-dust barriers almost wherever they are placed in operating mines.

About a year ago a mine-safety man, who enters many mines in various parts of the United States, was asked to designate the best rock-dusted mine he had seen. Later it was found that the mine chosen had been rock-dusted wholly by hand at a cost of about 5 cents per linear foot of entry, no rooms being rock-dusted. In a summary of Paper No. 2 as to rock-dusting by the Safety in Mines Research Board of Great Britain, a British authority says: "The stone dust can be scattered by hand or it can be distributed by the ventilation current or by mechanical sprayers. Each of these methods is used, but scattering by hand appears to be often the best way to remove the fine coal-dust (which is most dangerous) from the upper surface of timbers to replace it with stone dust." From this statement it is apparently customary to do much hand rock-dusting in Great Britain.

In conclusion it appears that there is every reason why the face worker should rock-dust by hand as the face progresses, and that the rock-dust should be supplied to him by the company as rails, ties, and timbers now are. This will insure that all surfaces of advancing openings have at least one coating of rock-dust and will also render the protection of those surfaces much less difficult later on when the face region has gone forward. This method also distributes the responsibility, for since both mine workers and company are protected by rock-dusting it is fair and equitable that both should aid in securing the protection. The ideal method of protection against widespread explosions is to have the mine sufficiently ventilated to hold the methane content of mine air below 1 per cent at all times and in all places; to use permissible explosives with electrical detonation, and preferably to have all loading and firing done after the general working shift is out of the mine; where electricity is used to employ nothing but permissible electrical equipment and to hold open wiring, motors, and switches away from gassy or dusty faces as much as possible; to have the mine piped with water lines to all working faces and to use water on the cutter bar of all mining-machine cutting chains while operating and on all coal piles and roof, rib, and floor surfaces from the face back 25 to 40 feet while loading coal either by hand or by machine; to rock-dust by hand the region immediately back of the face as the face advances, leaving about 25 to 40 feet at the immediate face to be kept wet by hosing; and to have the company maintain the rock-dusting by machine, air-carrying, or hand-dusting of haulage and all other accessible places which periodical (preferably monthly) sampling indicates have incombustible less than 65 per cent, or in other words to redust when dust samples from mine surfaces show combustible above 35 per cent. The cost of this program is by no means as great as our mining companies usually apprehend, and at any rate the cost of the program is infinitely less than is the cost of widespread explosions such as have been occurring with monotonous regularity year by year in the United States.

****

Digitized by Google